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HELIUM-NEON LASER ASSOCIATED WITH LASERSCOPE.(U)
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UNITED STATES ARMY ENVIRONMENTAL HYGIENE AGENCY

ABERDEEN PROVING GROUND, MD 21010

AEHA

NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 25-42-0339-82
HELIUM-NEON LASER ASSOCIATED WITH LASERSCOPE®
19 AUGUST 1981

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Helium-Neon Laser
Laser Rifle

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An optical radiation special study of the Laserscope was performed on the Laserscope during August 1981. It was determined that the 2.5 mW unit posed a hazard to the unprotected eye within 10 m even for momentary viewing (0.25 s). The 0.5 mW units did not present this hazard, assuming the output does not exceed 1 mW (no 0.5 mW units were available for measurement). Intrabeam viewing of the 2.5 mW unit should not be permitted within 135 m for lengthy time periods. Intrabeam viewing with optical instruments should not be permitted within 150 m.

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DEPARTMENT OF THE ARMY Mr. Marshall/ldr/AUTOVON
U S. ARMY ENVIRONMENTAL HYGIENE AGENCY 584-3932
ABERDEEN PROVING GROUND. MARYLAND 21010

REPLY TO
ATTENTION OF
HSE-RL/WP

20 NOV 1981

SUBJECT: Nonionizing Radiation Protection Special Study No. 25-42-0339-82, Helium-Neon Laser Associated with Laserscope®, 19 August 1981

Director
Army Night Vision and Electro-
Optics Laboratory
Fort Belvoir, VA 22060

A summary of the pertinent findings and recommendations follows:

An optical radiation special study of the Laserscope was performed on the Laserscope during August 1981. It was determined that the 2.5 mW unit posed a hazard to the unprotected eye within 10 m even for momentary viewing (0.25 s). The 0.5 mW units did not present this hazard assuming the output does not exceed 1 mW (no 0.5 mW units were available for measurement). *Intrabeam viewing of the 2.5 mW unit should not be permitted within 135 m for* lengthy time periods. Intrabeam viewing with optical instruments should not be permitted within 150 m. It was recommended that a warning label be placed on the unit and the above-mentioned distances be observed.

FOR THE COMMANDER:

for Alexander J. Sohany LTC

1 Incl
as (5 cy)

JOSEPH T. WHITLAW, JR
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DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

REPLY TO ATTENTION OF
HSE-RL/WP

NONIONIZING RADIATION PROTECTION SPECIAL STUDY NO. 25-42-0339-82 HELIUM-NEON LASER ASSOCIATED WITH LASERSCOPE®

19 AUGUST 1981

1. AUTHORITY. Letter, DELNV-L, Army Night Vision and Electro-Optics Laboratory, 28 July 1981, subject: Request for Hazard Analysis.

2. REFERENCES.

a. Paragraph 2-34a(7), AR 10-5, Department of the Army, Organization and Functions, 1 December 1980.

b. AR 40-46, Control of Health Hazards from Lasers and Other High Intensity Optical Sources, 6 February 1974, with Change 1 dated 15 November 1978.

c. TB MED 279, Control of Hazards to Health from Laser Radiation, 30 May 1975.

d. Message, 281315Z Aug 81, this Agency, subject: Preliminary USAEHA Evaluation of Laserscope.

3. PURPOSE. The purpose of this study was to evaluate possible optical radiation hazards associated with the He-Ne Laser used in the Laserscope, and to make recommendations necessary to eliminate exposure of personnel to potentially hazardous optical radiation from this device.

4. GENERAL.

a. Background. The Laserscope was developed by Laser Devices, Inc., Pacific Grove, CA. The Army Night Vision and Electro-Optics Laboratory requested this Agency to evaluate this device since the US Army Marksmanship Training Unit at Fort Benning expressed interest in it. Only the 2.5 mW unit was delivered to this Agency for evaluation. A photograph of the Laserscope is shown in Figure 1.

b. Inventory. At the time of this study no units had been purchased by the Army.

c. Instrumentation.

(1) United Detector Technology Model 40X Optometer with Radiometric Filter.

® Laserscope is a registered trademark of Laser Devices, Inc., Pacific Grove, CA. Use of trademarked names does not imply endorsement by the US Army, but is intended only to assist in identification of a specific product.

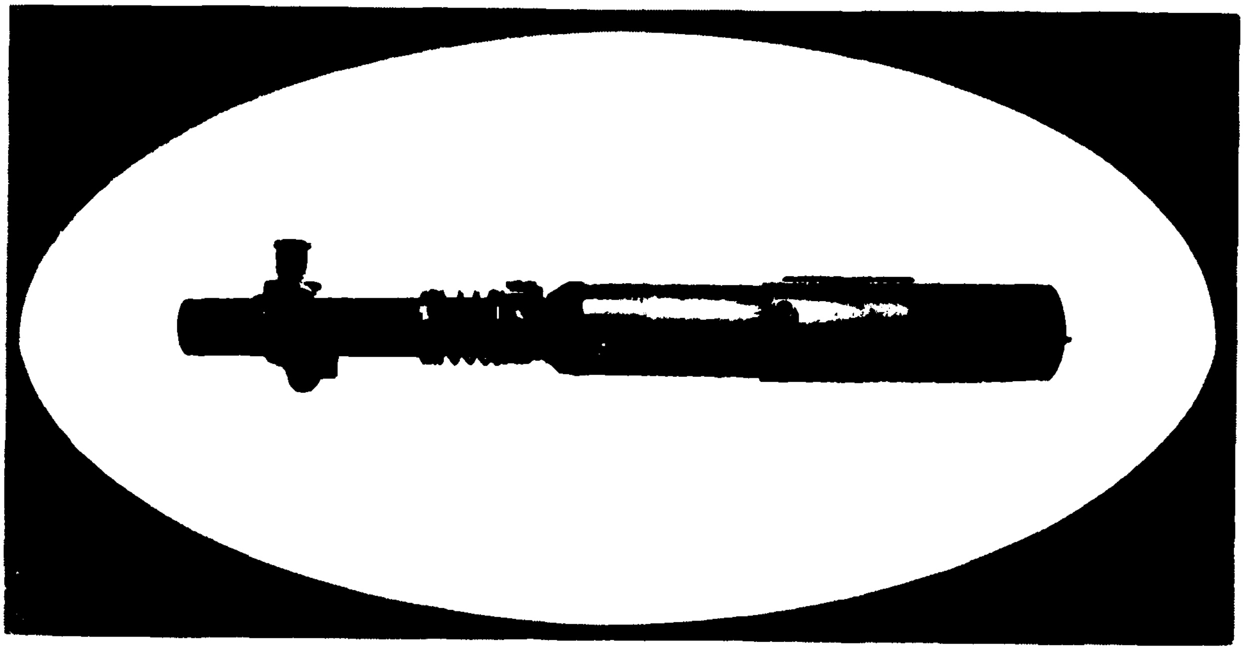


Figure 1. PHOTOGRAPH OF THE LASERSCOPE.

(2) Calibrated apertures.

d. Radiometric Terms and Units. The Appendix provides a table of the radiometric and photometric terms and units used in this report.

5. FINDINGS.

a. Laser output parameters.

(1) Power output: LPT 107-2.5 mW, 1.1 mW measured LPT 105-0.5 mW, LPT 106-0.5 mW, not measured.

(2) Beam Diameter: LPT 107 0.63 mm
LPT 106 0.63 mm
LPT 105 0.63 mm

(3) Divergence: 1.0 mrad, 1.0 mrad at 1/e points measured.

b. Beam Characteristics as a Function of Range. The He-Ne beam spreads rapidly as shown in Figure 2. The irradiance falls below the criteria for momentary viewing within 10 m at the specified output power of 2.5 mW.

c. Warning Label. No warning labels were on the device.

6. DISCUSSION.

a. The Direct Beam.

(1) Momentary viewing. The 2.5 mW Laserscope produced a momentary viewing hazard within 10 m of the laser exit. The 0.5 mW devices did not produce this hazard with the assumption that the output was indeed less than 1 mW (these units were not measured). Since the measured output was 1.1 mW, this device only produced a momentary viewing hazard within 5 m.

(2) Long-Term Viewing. The Laserscope produced a long-term viewing hazard within 135 m for viewing times in excess of 2.8 hours or 18 m for 10 s viewing.

(3) Optically Aided Viewing. The Laserscope produced a momentary hazard for an individual viewing with optical aids such as binoculars or telescopes within 150 m.

b. Specular Reflections. Due to the short hazardous distance of 10 m, specular reflections are of little consequence.

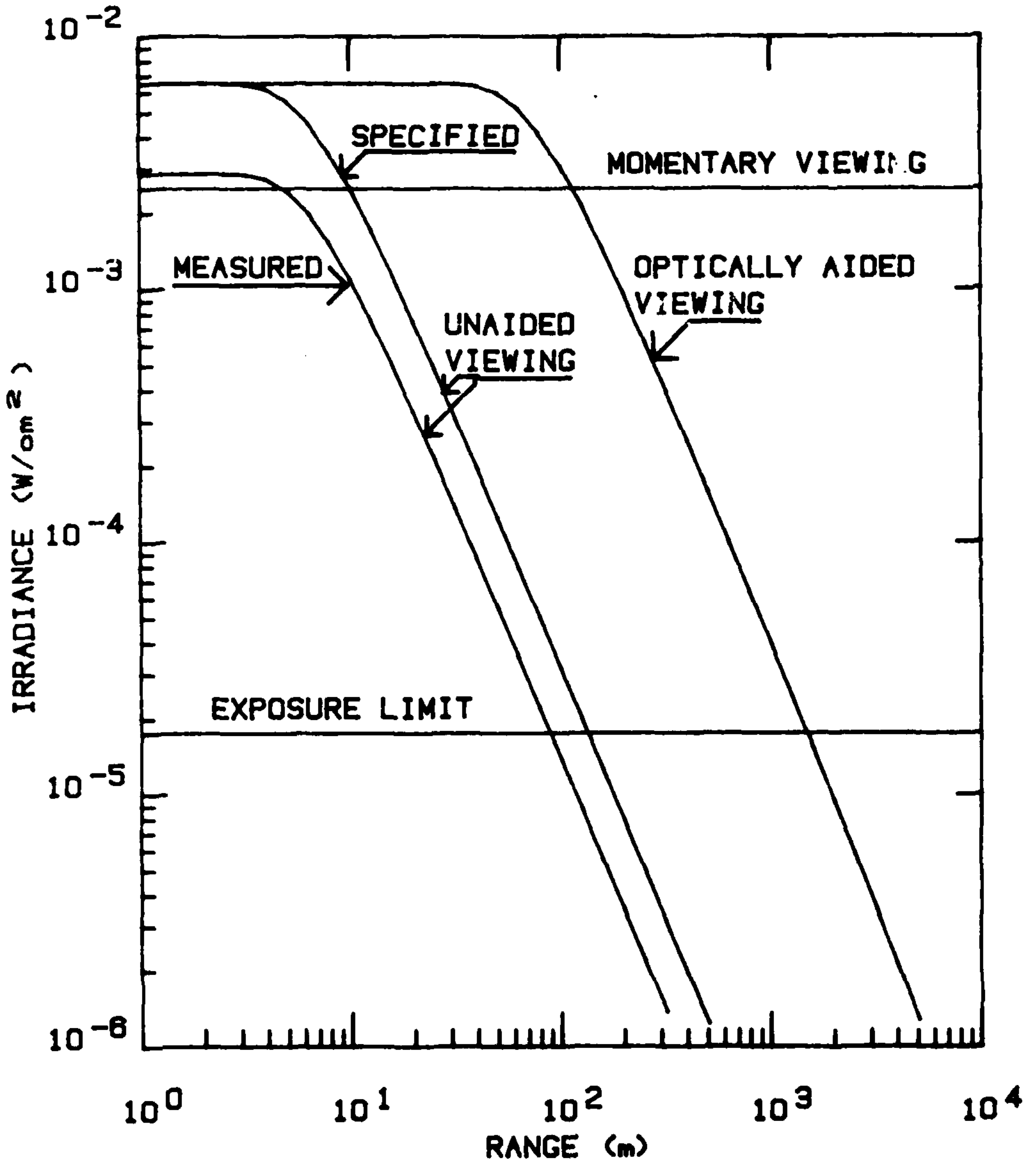


FIGURE 2. IRRADIANCE VERSUS RANGE FOR THE 2.5mW HELIUM-NEON LASER USED WITH THE LASERSCOPE.

c. Diffuse Reflections. Diffuse reflections are not hazardous from this device.

7. CONCLUSION. The Laserscope emits optical radiation in excess of current protection standards. However, this device may be used safely, provided the operators are informed of the hazards and take the appropriate precautions.

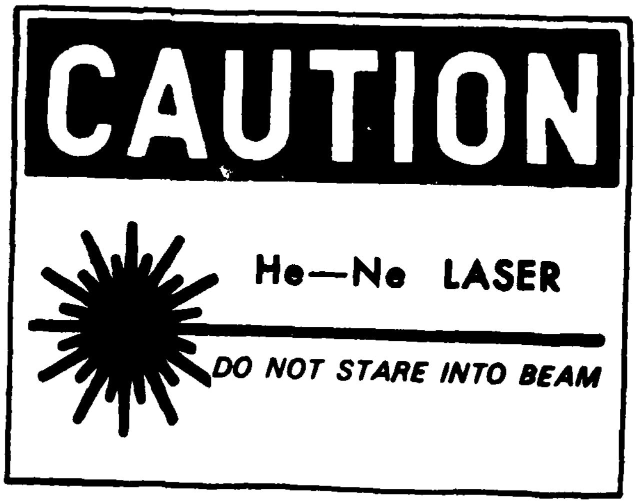
8. RECOMMENDATIONS.

a. Install a label, as shown below, on the 2.5 mW device, warning personnel not to point the device at a person's face within 10 m [paragraph 1-5d(1), AR 40-46].

AEHA Label 3, 1 Jun 80 (HSE-RL) TB MED 279

b. Do not look into the laser beam with optical devices within 150 m [paragraph 5-38b(5), AR 40-5].

c. Place a Caution Label on the 0.5 mW devices as shown below [paragraph 1-5d(1), AR 40-46].



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APPENDIX

USEFUL CIE RADIOMETRIC AND PHOTOMETRIC TERMS AND UNITS[1,2]

RADIOMETRIC				PHOTOMETRIC			
Term	**Symbol**	**Defining Equation**	**SI Unit and Abbreviation**	**Term**	**Symbol**	**Defining Equation**	**SI Units and Abbreviation**
Radiant Energy	Q_e		Joule (J)	Quantity of Light	Q_v	$Q_v = \int \Phi_v dt$	lumen-second (lm·s) (talbot)
Radiant Energy Density	W_e	$W_e = \frac{dQ_e}{dV}$	Joule per cubic meter ($J \cdot m^{-3}$)	Luminous Energy Density	W_v	$W_v = \frac{dQ_v}{dV}$	talbot per square meter ($lm \cdot s \cdot m^{-3}$)
Radiant Power (Radiant Flux)	Φ_e, P	$\Phi_e = \frac{dQ_e}{dt}$	Watt (W)	Luminous Flux	Φ_v	$\Phi_v = 680 \int \frac{d\Phi_e}{d\lambda} V(\lambda)\, d\lambda$	lumen (lm)
Radiant Exitance	M_e	$M_e = \frac{d\Phi_e}{dA} = \int L_e \cdot \cos\theta \cdot d\Omega$	Watt per square meter ($W \cdot m^{-2}$)	Luminous Exitance	M_v	$M_v = \frac{d\Phi_v}{dA} = \int L_v \cdot \cos\theta \cdot d\Omega$	lumen per square meter $lm \cdot m^{-2}$
Irradiance or Radiant Flux Density (Dose Rate in Photobiology)	E_e	$E_e = \frac{d\Phi_e}{dA}$	Watt per square meter ($W \cdot m^{-2}$)	Illuminance (luminous flux density)	E_v	$E_v = \frac{d\Phi_v}{dA}$	lumen per square meter ($lm \cdot m^{-2}$) lux (lx)
Radiant Intensity	I_e	$I_e = \frac{d\Phi_e}{d\Omega}$	Watt per steradian ($W \cdot sr^{-1}$)	Luminous Intensity (candlepower)	I_v	$I_v = \frac{d\Phi_v}{d\Omega}$	lumen per steradian ($lm \cdot sr$) or candela (cd)
Radiance	L_e	$L_e = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	Watt per steradian and per square meter ($W \cdot sr^{-1} \cdot m^{-2}$)	Luminance	L_v	$L_v = \frac{d^2\Phi_e}{d\Omega \cdot dA \cdot \cos\theta}$ [5]	candela per square meter ($cd \cdot m^{-1}$)
Radiant Exposure (Dose in Photobiology)	H_e	$H_e = \frac{dQ_e}{dA}$	Joule per square meter ($J \cdot m^{-2}$)	Light Exposure	H_v	$H_v = \frac{dQ_v}{dA} = \int E_v dt$	lux-second (lx·s)
				Luminous Efficacy (of radiation)	K	$K = \frac{\Phi_v}{\Phi_e}$	lumen per watt ($lm \cdot W^{-1}$)
				Luminous Efficiency (of a broad band radiation)	$V(\cdot)$	$V(\cdot) = \frac{K}{K_m} = \frac{K}{680}$	unitless
Radiant Efficiency [3] (of a source)	η_e	$\eta_e = \frac{P}{P_i}$	unitless	Luminous Efficacy[3] (of a source)	η_v	$\eta_v = \frac{\Phi_v}{P_i}$	lumen per watt ($lm \cdot W^{-1}$)
Optical Density [4]	D_e	$D_e = -\log_{10} \tau_e$	unitless	Optical Density[4]	D_v	$D_v = -\log_{10} \tau_v$	unitless
				Retinal Illuminance in Trolands	E_t	$E_t = \frac{L_v}{S_p}$	troland (td) = luminance in $cd \cdot m^{-2}$ times pupil area in mm^2

1. The units may be altered to refer to narrow spectral bands in which case the term is preceded by the word *spectral*, and the unit is then per wavelength interval and the symbol has a subscript λ. For example, spectral irradiance H_λ has units of $W \cdot m^{-2} \cdot m^{-1}$ or more often, $W \cdot cm^{-2} \cdot nm^{-1}$.

2. While the meter is the preferred unit of length, the centimeter is still the most commonly used unit of length for many of the above terms and the nm or um are most commonly used to express wavelength.

3. P_i is electrical input power in watts.

4. τ is the transmission.

5. At the source $I = \frac{dI}{dA \cdot \cos\theta}$ and at a receptor $I = \frac{dI}{d\Omega}$

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